Lewis and Clark in Idaho
Lolo Trail Precision Survey

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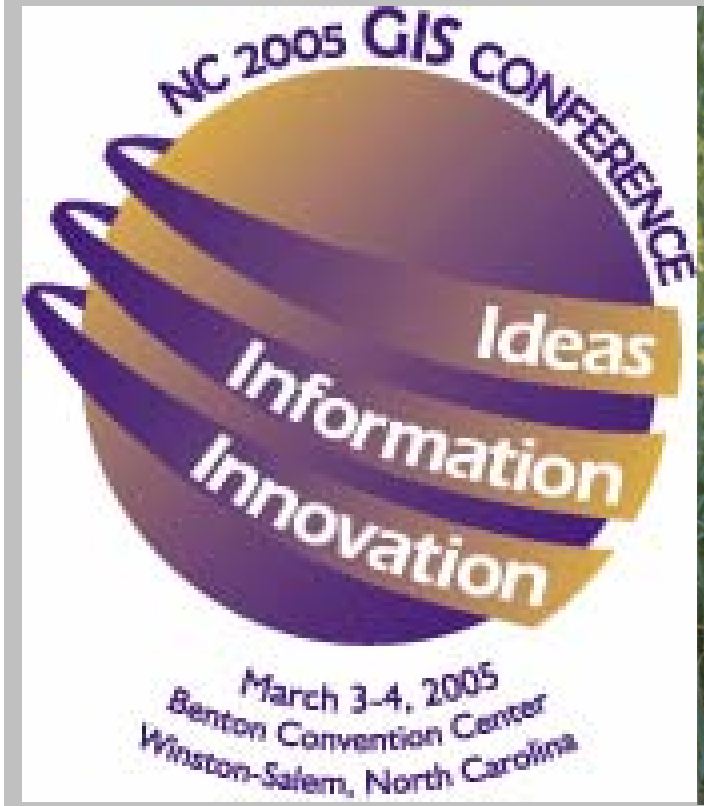
March 3, 2005

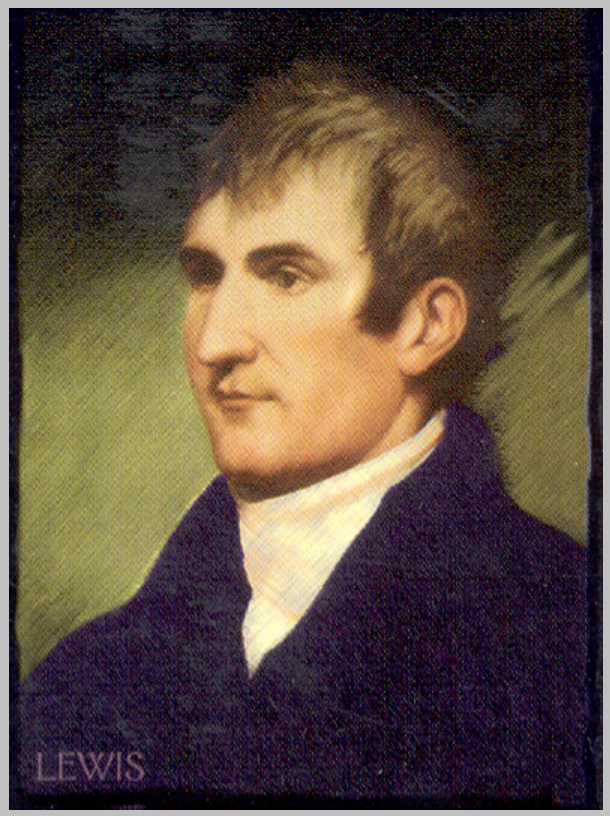


Salmon River Canyon in Idaho

Bitterroot Mountains in Idaho

Lewis and Clark

Co-Captains and Leaders



"The Naturalist"

"The Map Maker"

The Trail of Lewis and Clark in Montana and Idaho

A 140 Year Search

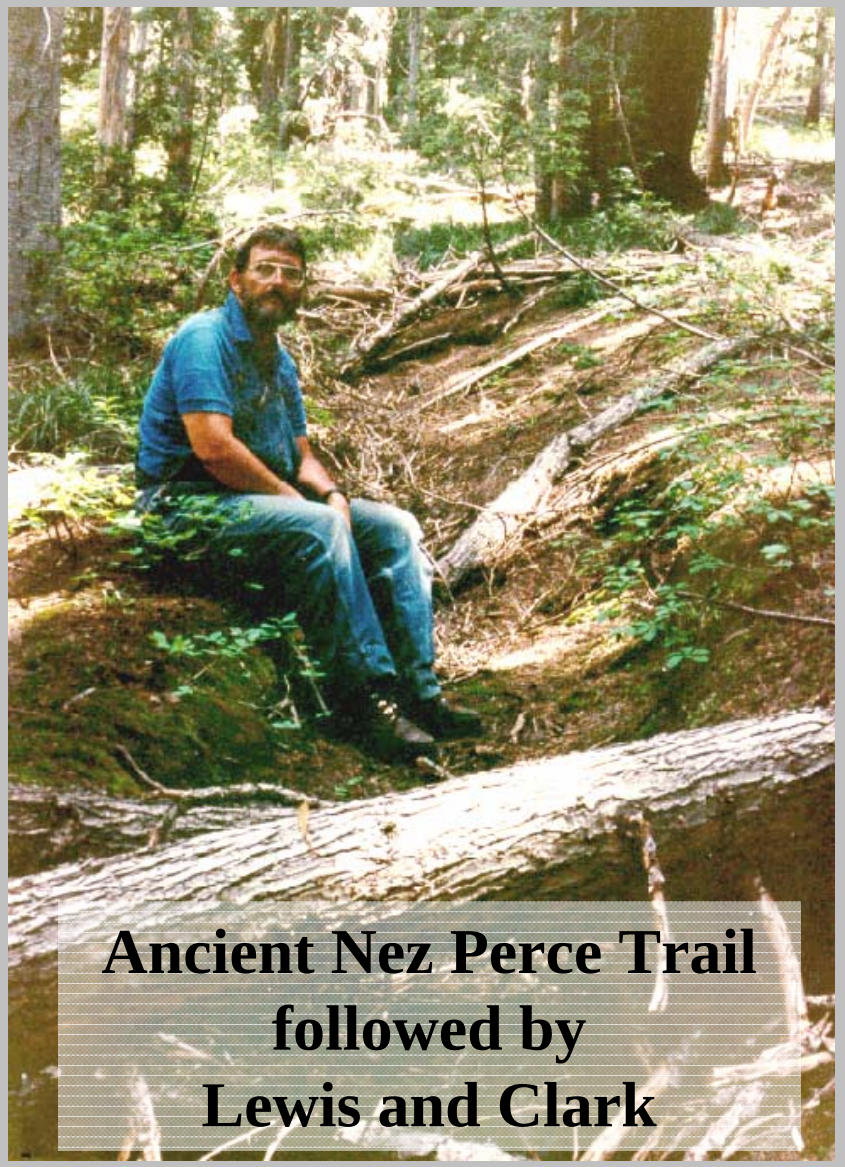
- **1866 – G. B. Nicholson surveyed over the route for a wagon road. Did not find much of the trail.**
- **1895 – Elliot Coues tries to locate the trail for his book. Consults Nicholson but does not use much of his material.**
- **1899 – Olin D. Wheeler researches the trail for his two-volume book on the trail but found only small portions of it. Produces the first topo map of the trail but it is highly inaccurate.**
- **1905 – Reuben G. Thwaites edits the first complete, unabridged version of the journals and maps. Uses Nicholson as a resource for its location but does not produce a modern map.**

In Search of the Trail of Lewis and Clark in Montana and Idaho (cont.)

- **1925 – Jack Harlan starts writing newspaper articles about the trail but does not find much of it or produce any maps.**
- **1966 – John Peebles writes the official version of a booklet on Lewis and Clark in Idaho**
- **1968 – Ralph Space writes a small book on the trail. Discusses campsites but does not include the trail or maps.**
- **1985 – Steve F. Russell begins scholarly research on the trail employing:**
  - **computer analysis of the original journals and maps**
  - **summer field explorations and draft surveys**
  - **precision documentation of the trail tread with photography, precision GPS, and GIS.**

Steve F. Russell - Interests and Goals

- **Scholarly research on historic trails with original journals, original maps, and field work**
- **Work with state and federal agencies on historic preservation**
- **High-accuracy GIS results using ARCVIEW and Precision GPS**
- **Natural history documentation: geology, plants, animals**
- **Archival results: publications and documentation in state historical society journals**

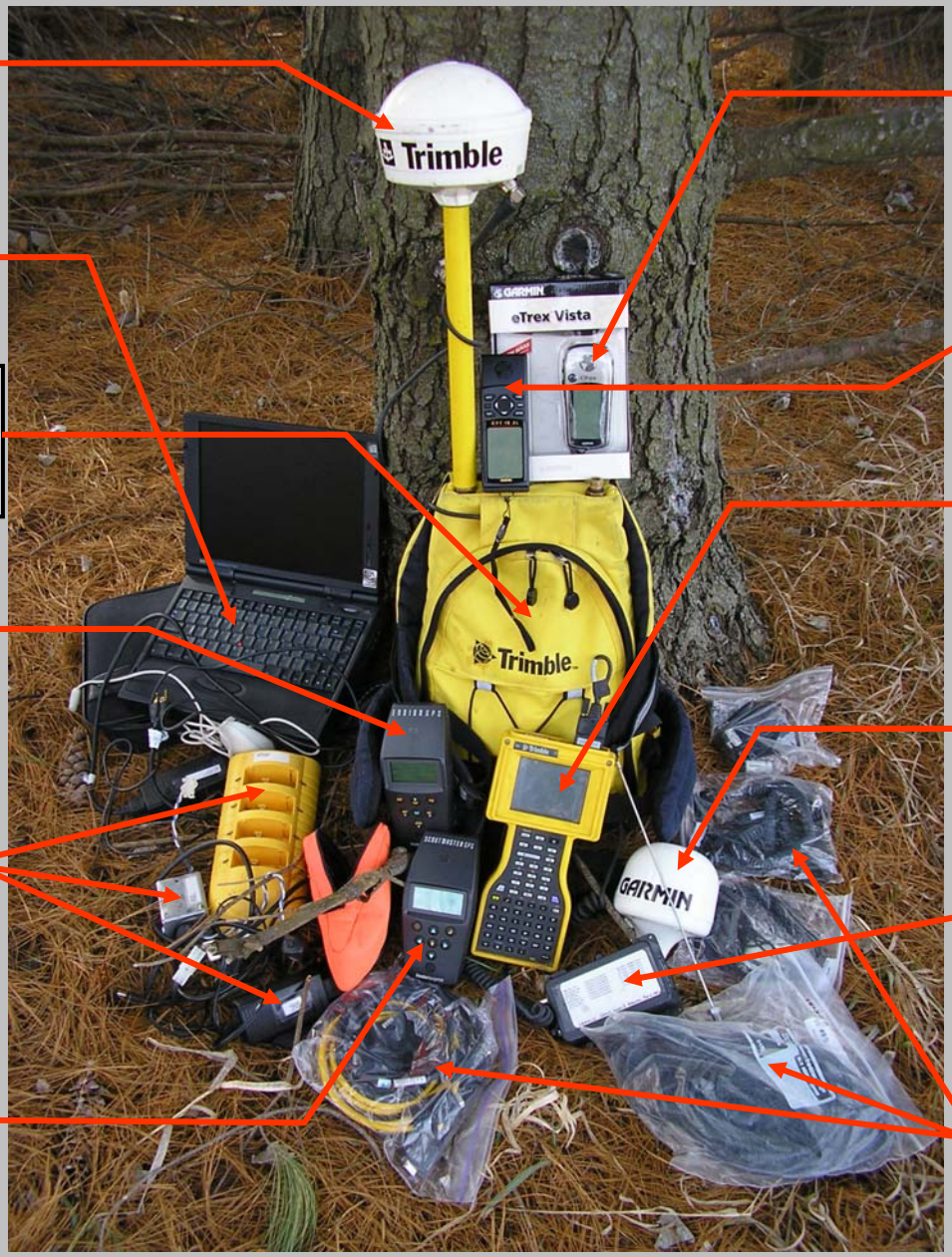


Ancient Nez Perce Trail followed by Lewis and Clark

Technology Summary

- US Geological Survey topographic maps
- USGS digital raster graphics maps
- ARCVIEW Geographic Information System precision mapping
- Trimble Pathfinder PRO/XRS precision survey quality GPS
- Trimble software
- Laptop with support software and CD archive
- Logistics: battery chargers, inverters

GPS Menagerie



Trimble 3-Mode Antenna

Laptop PC

Trimble Backpack Receiver

Trimble Ensign Handheld

Power Supplies and chargers for 12V and 120V

Trimble Scoutmaster Handheld

Garmin Etrex Vista Handheld

Garmin 12XL Handheld

Trimble Data-logger Computer

Garmin DGPS Mag Antenna

Garmin DGPS E-field Antenna

Cables for connecting units

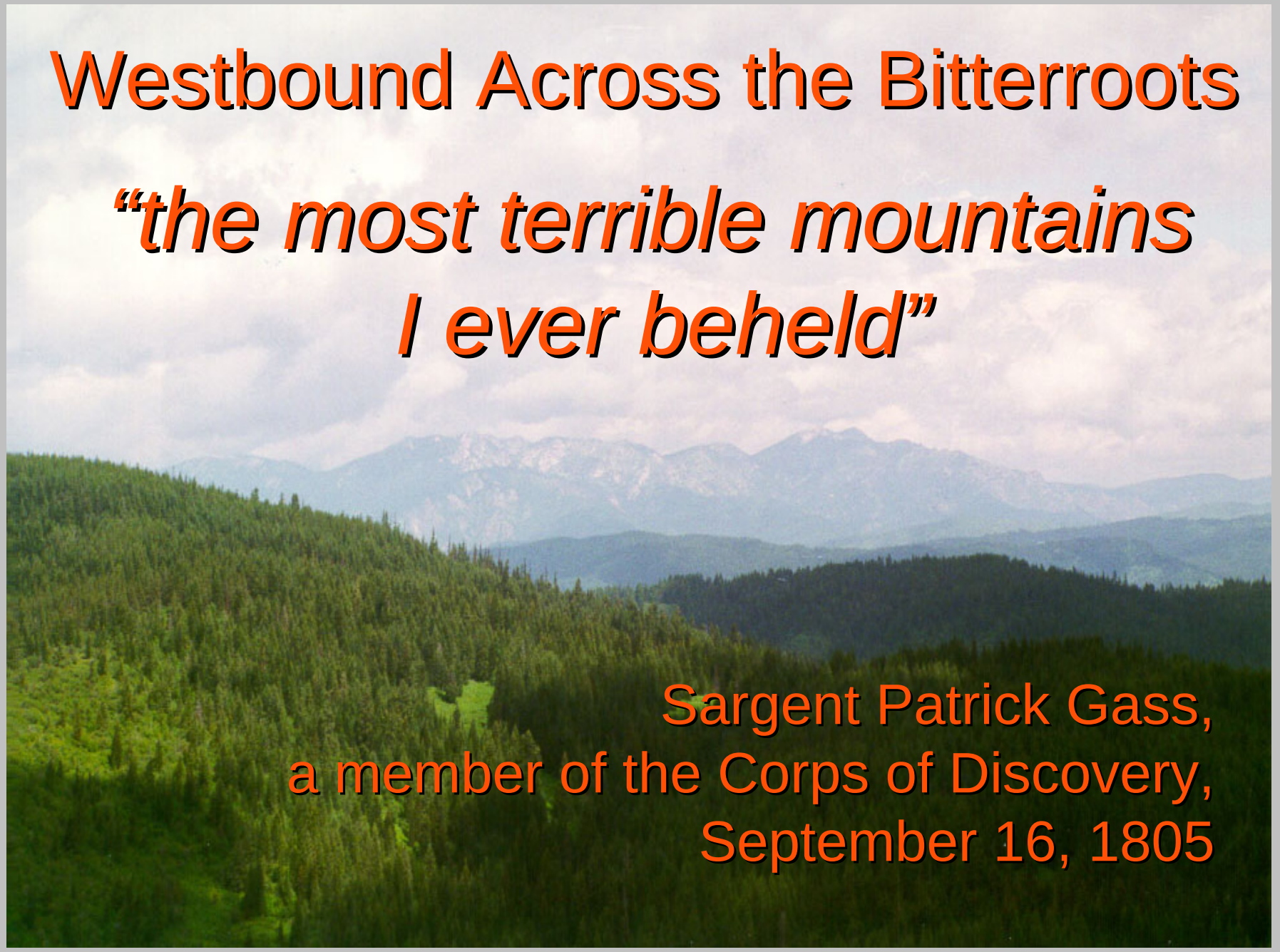
Precision Survey of the Lewis and Clark Trail in Idaho

A Legacy Project for Future Generations
2104-06

- 17 summers of field work locating the actual trail tread on the ground, 1986-2003
- Precision survey of 104 miles of trail tread, 2002, 2003
- Supported by a grant from the Lewis and Clark Bicentennial Assistance Grant Program of the State of Idaho

Westbound Across the Bitterroots

"the most terrible mountains I ever beheld"

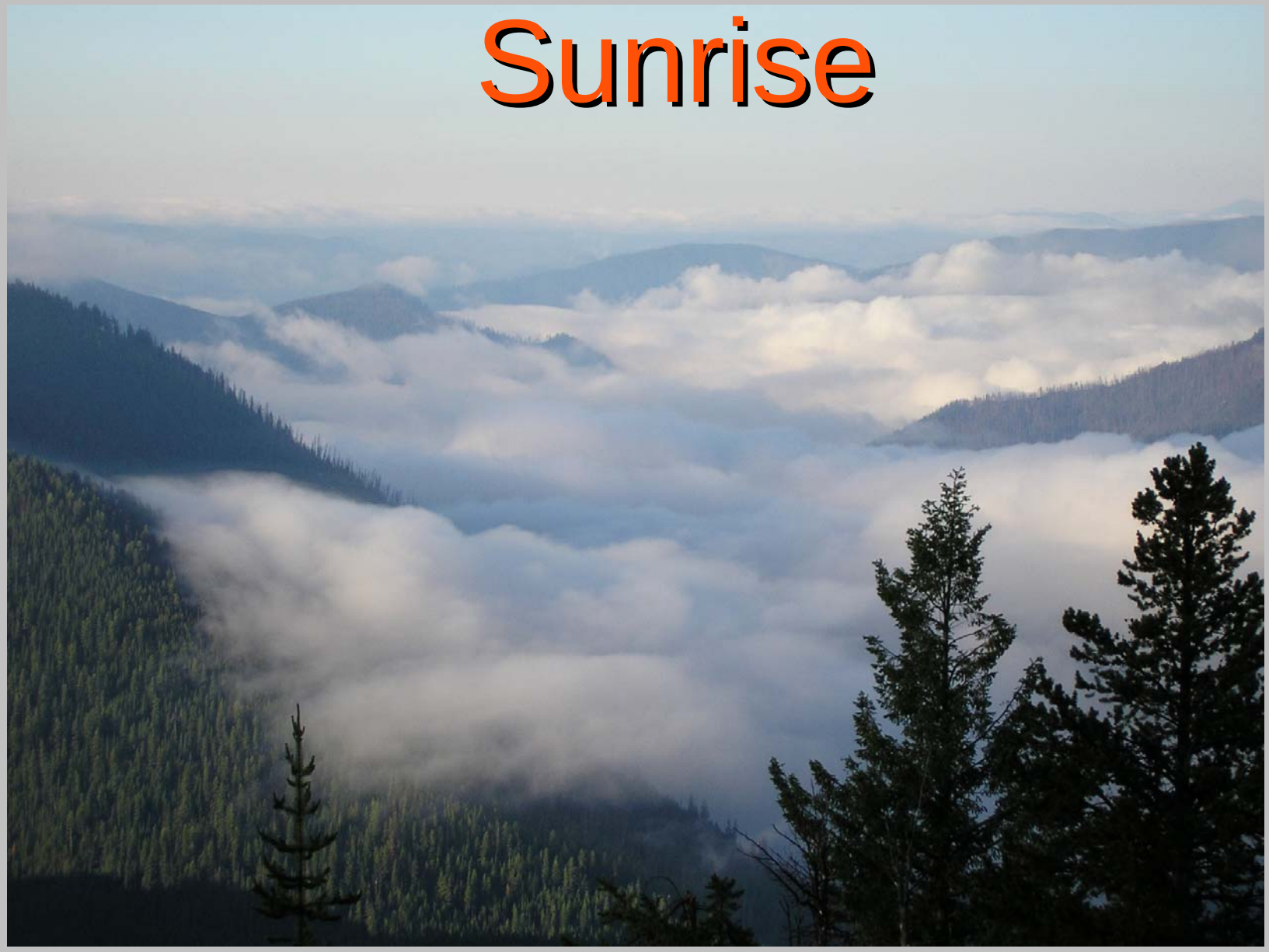


Sargent Patrick Gass,
a member of the Corps of Discovery,
September 16, 1805

LOLO SUMMIT
THE LEWIS AND CLARK PARTY CROSSED THIS PASS SEPT. 13, 1805, WESTBOUND FOR THE PACIFIC AFTER A LONG DETOUR TO THE SOUTH.
From the headwaters of the Missouri they had crossed the mountains to the Salmon. Finding that river impassable, they traded for packhorses, hired an Indian guide, and came north to an Indian trail across the mountains here. Tired and ill-fed, the men were to have a hard struggle in early snow along the steep ridges which the trail followed for most of its 125 mile course west to the Clearwater River.
247
12
95
Moscow
Lewiston
Orofino
Lowell
Ahsahka
LOLO SUMMIT

Land of the Nez Perce

Sunrise



ELEVATION
6764 FEET

Trimble Pathfinder at Smoking Place

Cone Flowers and Stinging Nettles
"Are we having fun yet"

PMI
15

Let's Improve on the Expedition Maps

Mapmaker: William Clark

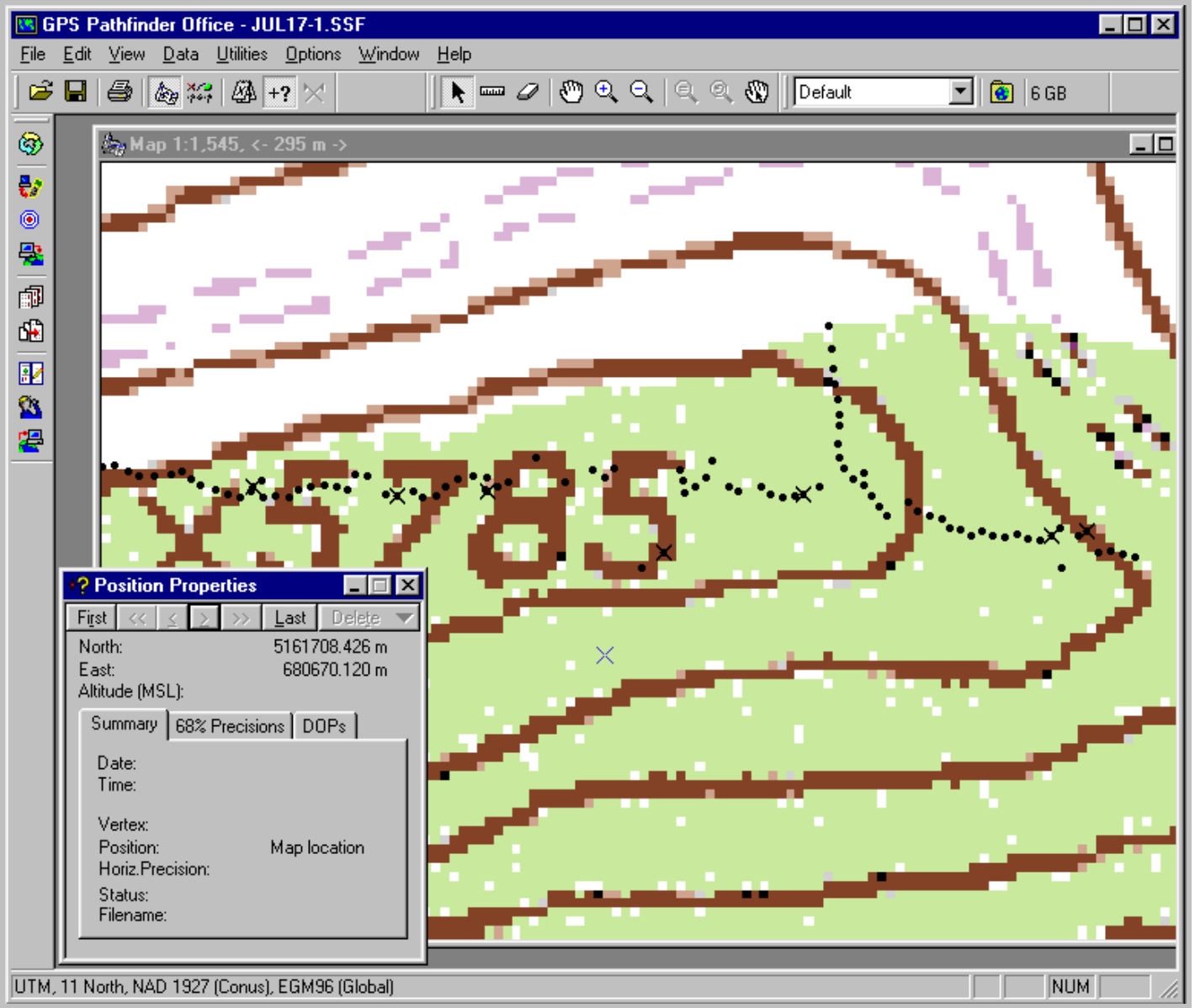
Lolo Creek and Hungary Creek in the Bitterroot Mountains of North-Central Idaho

NC 2005 GIS Conference, Winston-Salem, NC, March 3, 2005, Steve F. Russell, Iowa State University

Screen Shot of Pathfinder Map and data

Initial Raw Survey Data with Topo Map

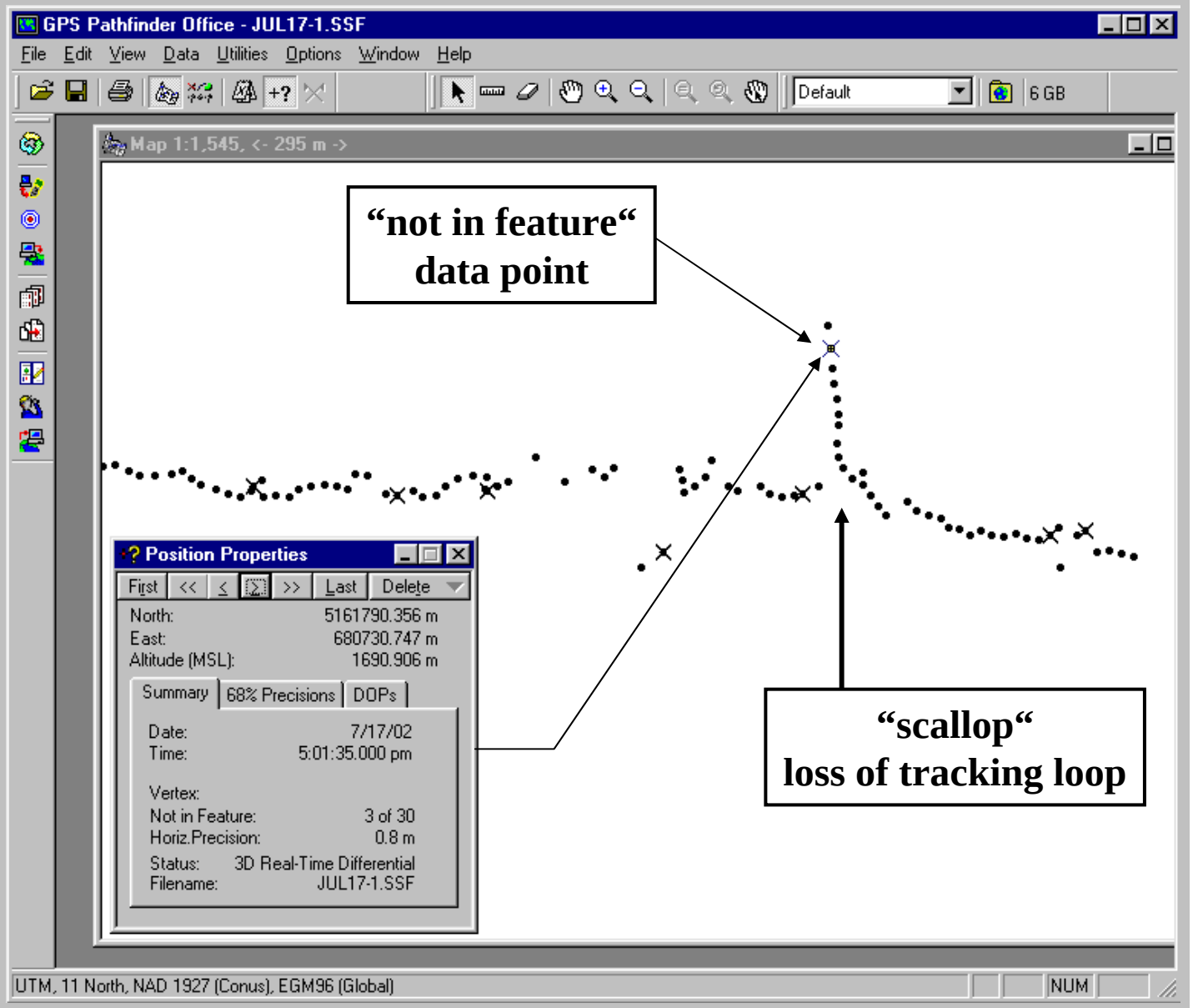
- **Quad: Rocky Ridge**
- **Locality: Rocky Ridge Lookout**
- **DRG: o46114e6**
- **NAD 27 (conus) UTM**
- **ZONE: 11**
- **NORTH: 5161708**
- **EAST: 680670**



Screen Shot of Pathfinder Map and data (cont.)

Initial Raw Survey Data w/o Topo Map

- "Not in feature" points
- Status is 3D real-time differential GPS but tracking loop is not locked
- Horizontal precision is reported to be 0.8 meters
- Actual error is approximately 30 meters



Loss of Accuracy During Real-Time Tracking

- **Methods of DGPS**
  - **Coast Guard beacon**
  - **Subscription satellite system**
  - **Wide Area Augmentation System (WAAS) satellite**
  - **Base-Rover differential GPS**

In heavy forest canopy, only the low-frequency Coast Guard beacon in effective. DGPS satellite signals are too weak to be received.

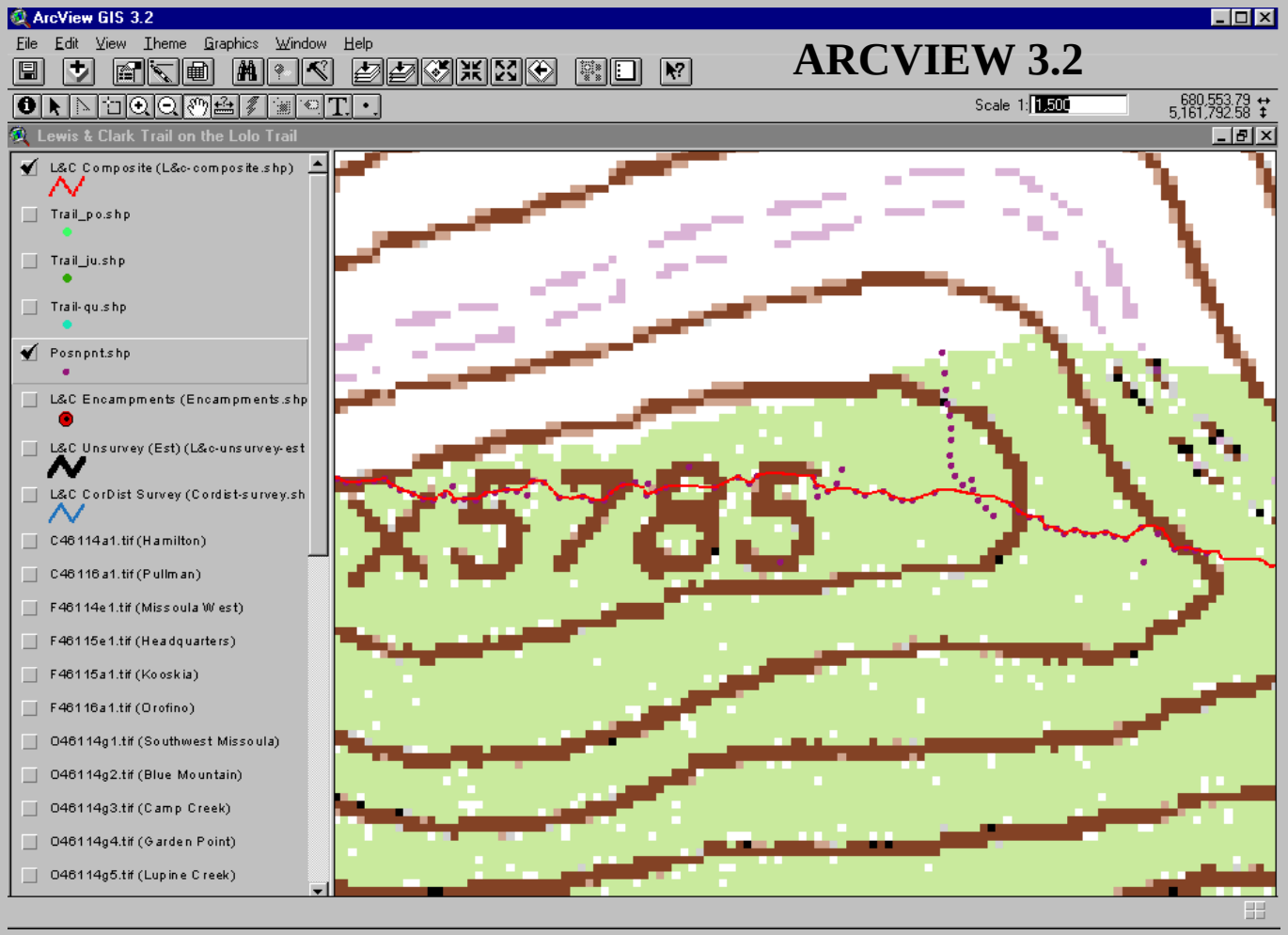
Although the Pathfinder receiver reported 3D differential GPS, its tracking loop had lost lock and gave an error almost 40 times larger than was reported

So far, the only effective solution to this problem has been to manually post-process the data

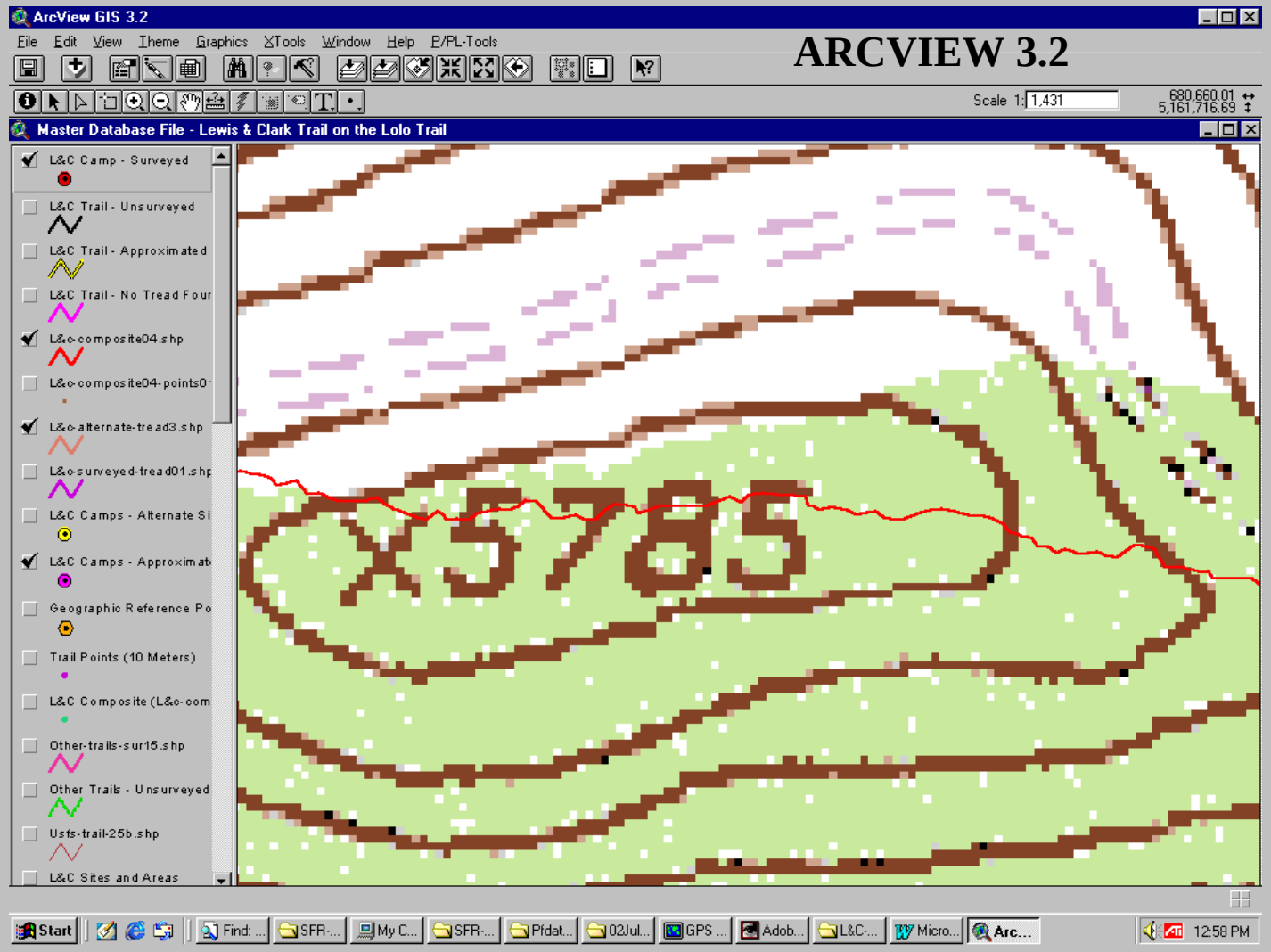
Manual Post-Processing of Data

Manual post-processing of data with ARCVIEW

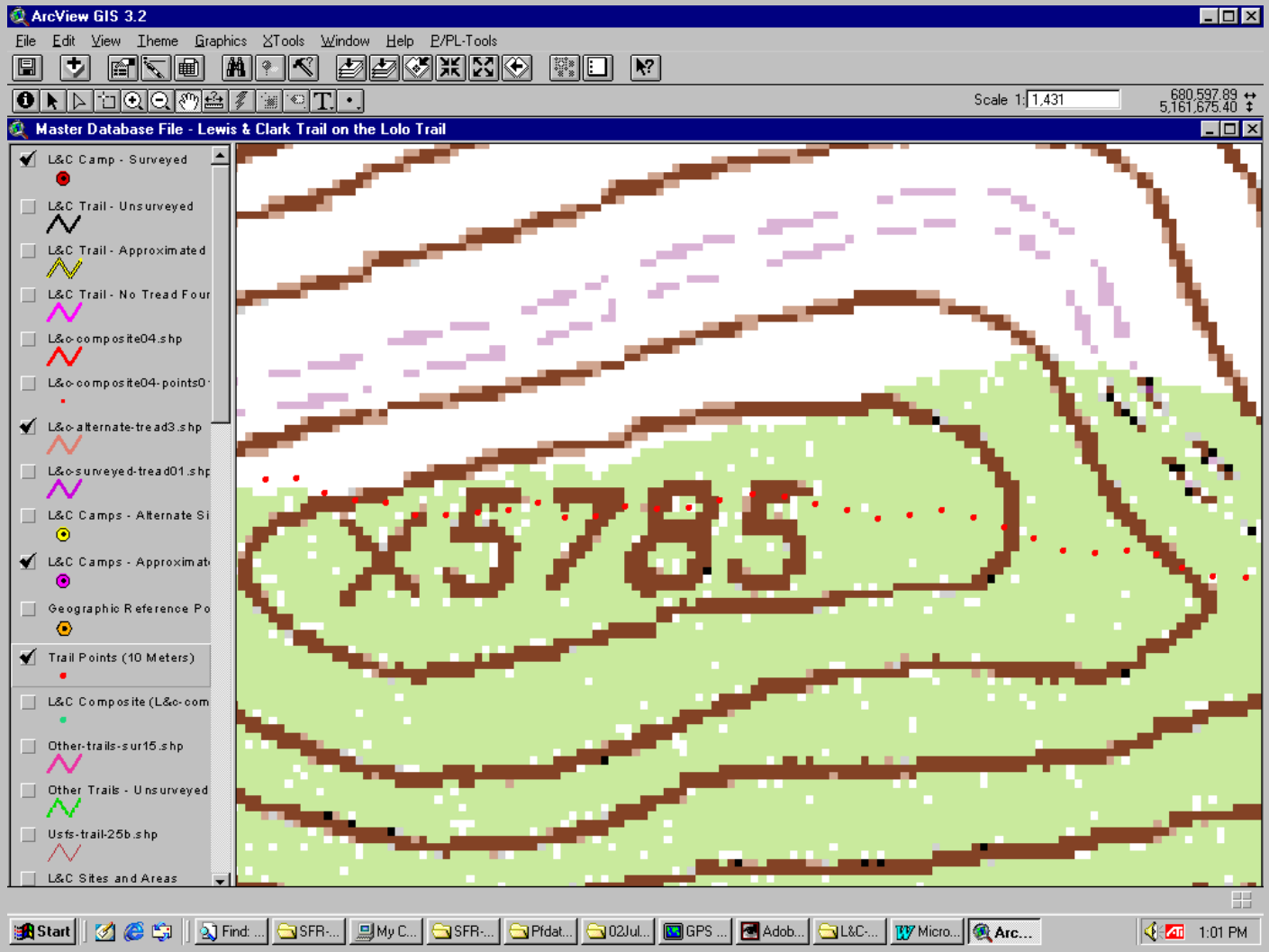
- Smooth line drawn between known good points
- Interpolation is used
- Scallops and other loss-of-tracking artifacts are removed
- Field notes and memorized trail features are used to assist interpolation



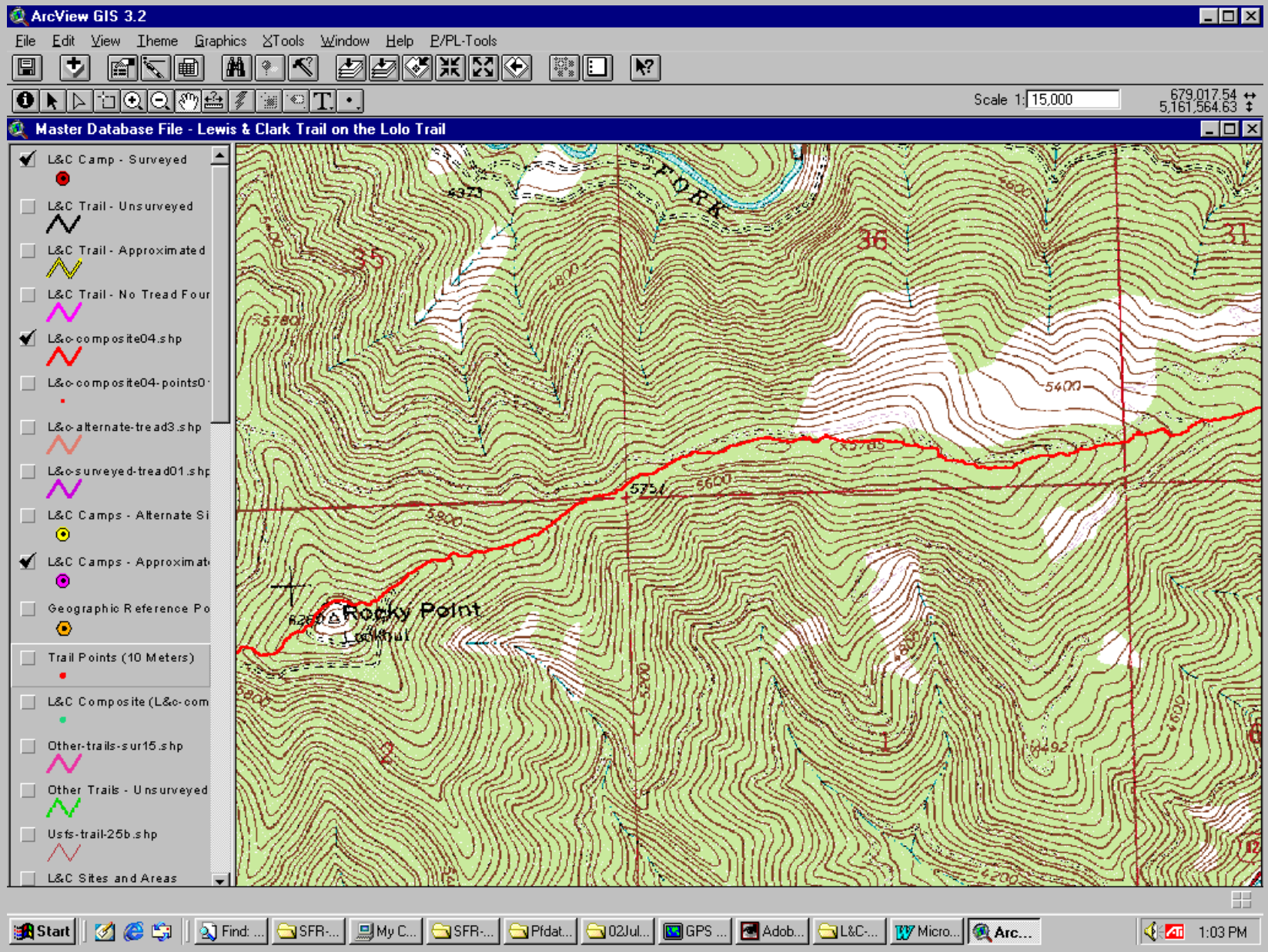
Final Results for Line Feature



Final Results for 10-Meter Point Feature

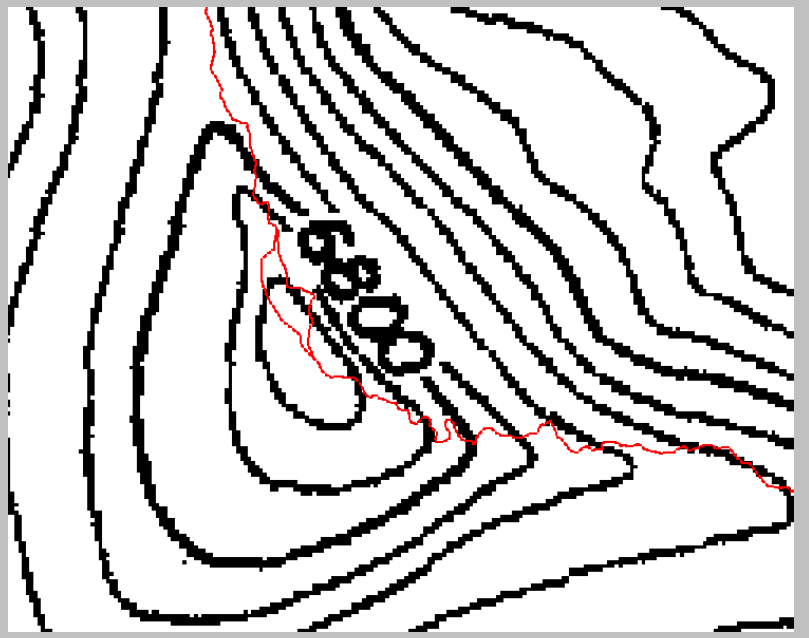


Zoom Out


ArcView GIS 3.2
File Edit View Theme Graphics XTools Window Help P/PL-Tools
Scale 1: 15,000
679,017.54
5,161,564.63
Master Database File - Lewis & Clark Trail on the Lolo Trail
L&C Camp - Surveyed
L&C Trail - Unsurveyed
L&C Trail - Approximated
L&C Trail - No Tread Four
L&c-composite04.shp
L&c-composite04-points0
L&c-alternate-tread3.shp
L&c-surveyed-tread01.shp
L&C Camps - Alternate Si
L&C Camps - Approximat
Geographic Reference Po
Trail Points (10 Meters)
L&C Composite (L&c-com
Other-trails-sur15.shp
Other Trails - Unsurveyed
Usfs-trail-25b.shp
L&C Sites and Areas
FORK
Rocky Point
Start
1:03 PM

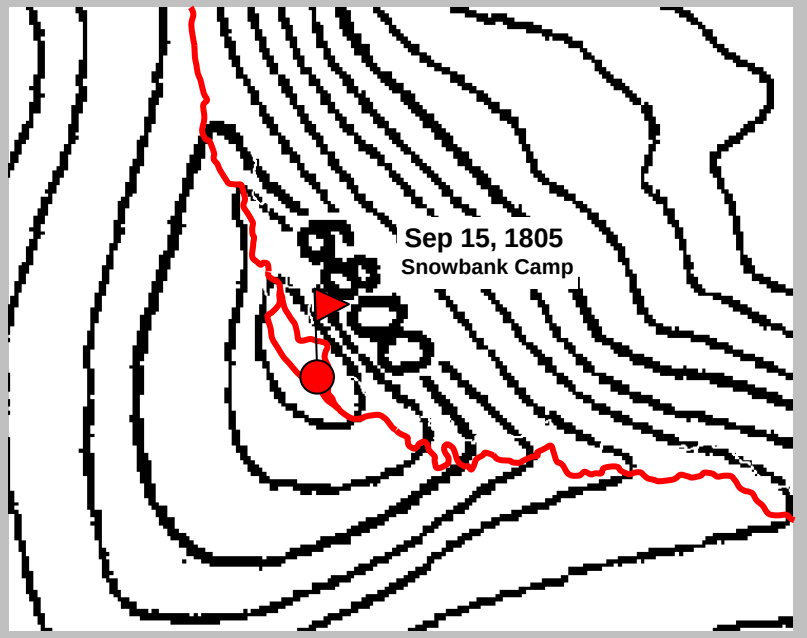
USGS Topographic Map Errors

Errors in a topographic map can make it look like the GPS plot is in error



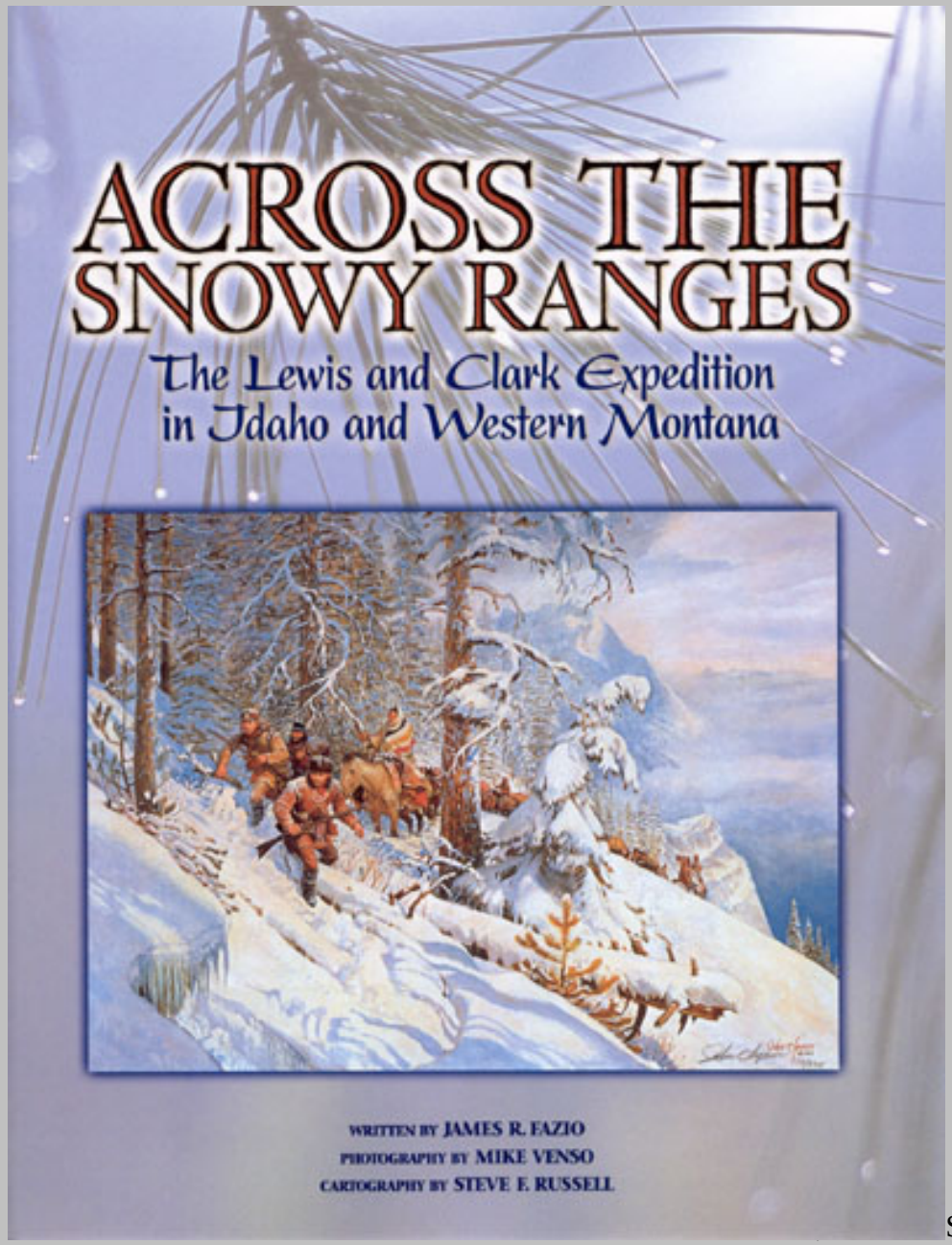
The map to the above right has the GPS data accurately plotted on a USGS 7.5 minute DRG. The map elevation contours are distorted and too far west and south of the actual location of this ridge

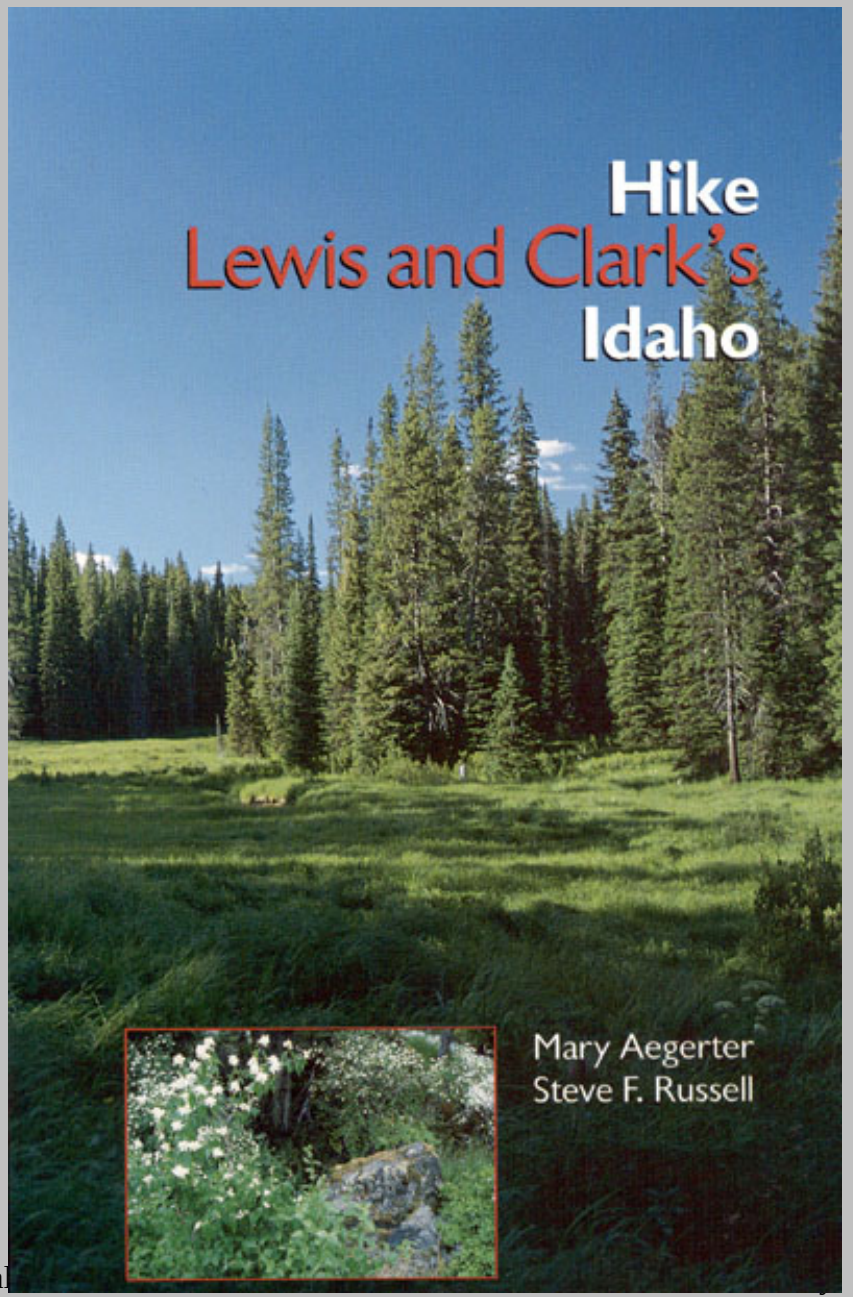
The GPS plot on the map to the below right has been distorted so that it appears to be in the correct location. This is fine for hiking and reading paper maps but any GPS readings taken from this map will be in error



Conclusion: The accuracy of USGS DRGs is not adequate for accurate portrayal of the both the correct UTM location and the perceived topographic location

Books


ACROSS THE SNOWY RANGES
The Lewis and Clark Expedition in Idaho and Western Montana
WRITTEN BY JAMES R. FAZIO
PHOTOGRAPHY BY MIKE VENSO
CARTOGRAPHY BY STEVE F. RUSSELL


Hike
Lewis and Clark's
Idaho
Mary Aegerter
Steve F. Russell

The End

Questions?

Photo Gallery 1

Photo Gallery 2

Research Methodology

- **What I do**
  - Document the history and precise location of historic trails
  - Apply the best technology and academic research methods available
- **How I do It**
  - Research using original journal and map sources from the National Archives and other research libraries
  - Apply computer technology to the journals and maps to determine the best probable location of the trails
    - Use various GIS tools
    - Delorme Street Atlas 4.0
    - National Geographic TOPO!
    - ESRI ARCVIEW 3.1

Research Methodology (cont.)

- **How I do It (cont.)**
  - Field explorations: dedicate summer months to extensive field work for tread discovery (exploring and camping)
  - Preliminary location survey with best available tools.
  - Precision survey with differential GPS (DGPS)
  - Precision location documentation using ARCVIEW
  - Create detailed maps of the trail location using geographic information system technology
  - Document the results by various archival means

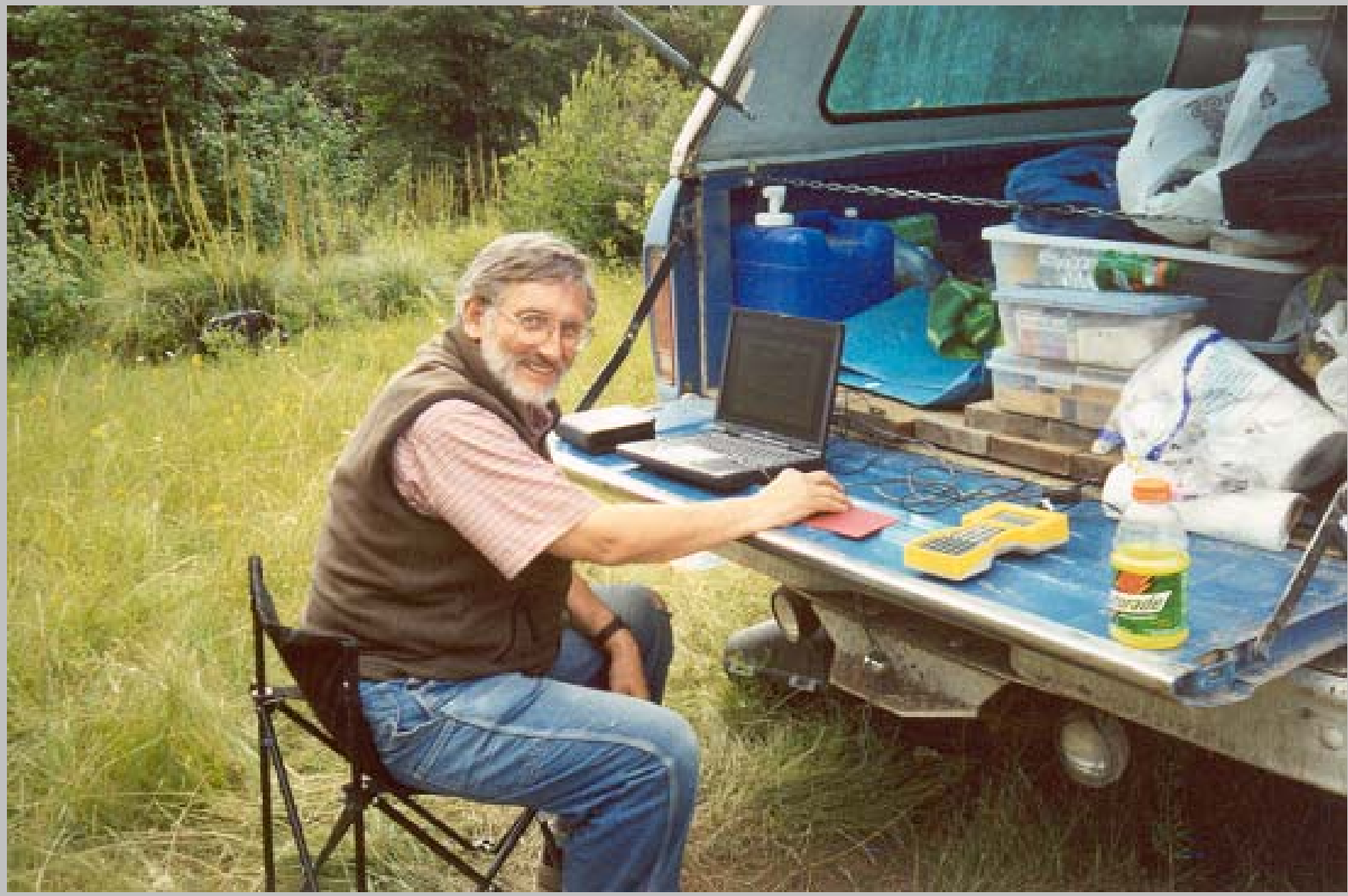
Zig-Zag Searching for the Trail

It takes a large amount of searching all around to find the trail tread

A bear has been inspecting this old log in search of insects

Initial Processing of Data

"A different kind of tailgating"



Steve F. Russell, Ph.D., P.E.

- **Native of Montana and Idaho**
- **BSEE, Montana State**
- **Ph.D. Iowa State**
- **Associate Professor, Iowa State**
- **17 years of research on Lewis and Clark Trail in Idaho and Montana**
- **Numerous publications on Lewis and Clark Trail**
- **Consultant to State of Idaho, Historic Preservation Office**

Trimble Pathfinder Pro XRS

- **Precision DGPS stand-alone unit**
- **Satellite, WAAS, and Coast Guard beacon DGPS**
- **8-10 hours of battery life in the field**
- **Highly flexible data logging**
- **Designed to minimize data errors in the field**
- **High performance receiver with multipath compensation**
- **Designed to operate in heavy forest canopy**

Last surviving plaque put along the trail by Jack Harlan, 1935

Issues for Getting the Job Done

- Public vs private land
- Rugged and marginally accessible areas
- Hungery creek (2 people got lost)
- Heavy forest canopy
  - Weak GPS signals
  - Multipath
  - No satellite-based DGPS, Coast Guard VLF beacon
- Tedious post-processing of data
  - Smoothing noise, line vs dots, wild points and scallops.
- Camping, cold, wet, rugged, no emergency medical help
- Keeping batteries charged

Data Logging Computer

Trimble TSCe

- **10 hours battery**
- **Windows CE operating system**
- **50 MB of flash memory**
- **Ruggedized**
- **Water resistant**

Independent Verification of Trail Location

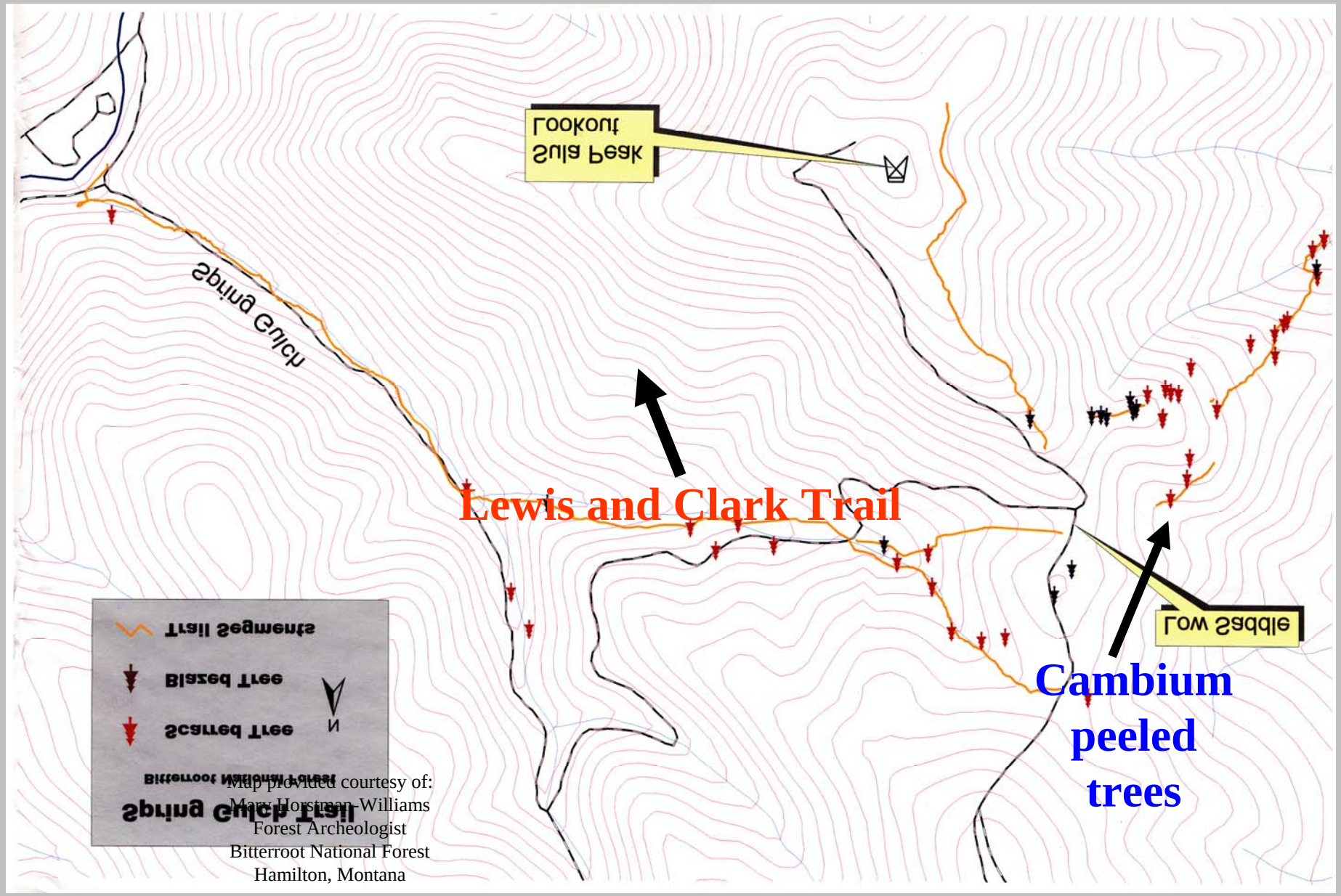
- **Scarred Trees**
  - Blazed Trees
  - Fire scarred trees
  - Porcupine feeding
  - **Cambium peeled trees****
- **Culturally Modified Trees**
  - Blazed trees
  - **Cambium pealed trees****

****Native Americans and early pioneers peeled the bark off of trees to reach the cambium layer which is rich in sugar during the springtime. This layer of bark was eaten by horses and chewed by people. Peeled trees often mark the location of ancient trails.**

Precision GPS Survey of Spring Gulch near Sula Peak in Montana

- Precision survey with Trimble Pathfinder PRO differential GPS (DGPS)
- Location and documentation of culturally modified trees
  - Blazed trees
  - Cambium peeled trees
- Precision location documentation using ESRI ARCVIEW

Culturally Modified Trees



Map provided courtesy of:
Mary Horstman-Williams
Forest Archeologist
Bitterroot National Forest
Hamilton, Montana

Example of a map page in an 8.5x11 inch format map atlas